



# **MARKSCHEME**

**May 2005**

**ENVIRONMENTAL SYSTEMS**

**Standard Level**

**Paper 2**

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## Subject Details: Environmental Systems SL Paper 2 Markscheme

### General

A markscheme often has more specific points worthy of a mark than the total allows. This is intentional. Do not award more than the maximum marks allowed for part of a question.

When deciding upon alternative answers by candidates to those given in the markscheme, consider the following points:

- ♦ Each marking point has a separate line and the end is signified by means of a semicolon (;).
- ♦ An alternative answer or wording is indicated in the markscheme by a “/”; either wording can be accepted.
- ♦ Words in ( ... ) in the markscheme are not necessary to gain the mark.
- ♦ The order of points does not have to be as written (unless stated otherwise).
- ♦ If the candidate’s answer has the same “meaning” or can be clearly interpreted as being the same as that in the mark scheme then award the mark.
- ♦ Mark positively. Give candidates credit for what they have achieved, and for what they have got correct, rather than penalizing them for what they have not achieved or what they have got wrong.
- ♦ Remember that many candidates are writing in a second language. Effective communication is more important than grammatical accuracy.
- ♦ Occasionally, a part of a question may require a calculation whose answer is required for subsequent parts. If an error is made in the first part then it should be penalized. However, if the incorrect answer is used correctly in subsequent parts then **follow through** marks should be awarded. Indicate this with “**ECF**”, error carried forward.
- ♦ Units should always be given where appropriate. Omission of units should only be penalized once. Indicate this by “**U-1**” at the first point it occurs. Ignore this, if marks for units are already specified in the markscheme.
- ♦ Do not penalize candidates for errors in significant figures, unless it is specifically referred to in the markscheme.

## SECTION A

1. name of ecosystem (*e.g.* beach, lake, forest but not *e.g.* “freshwater”);  
arrows in correct direction;  
three trophic levels correctly labelled (accept 1st, 2nd, 3rd / primary producers, primary consumers, secondary consumers / plants, herbivores, carnivores);

*organisms:*

*Award [2] for 6 or 7 organisms (from 3 trophic levels) correctly labelled.*

*Award [1] for 4 or 5 organisms (from 3 trophic levels).*

**[5 max]**

*Accept as names: grass, trees, fish and give benefit of doubt with exotic names.*

*If a single food-chain is drawn, award [3 max]. Marks should not be awarded for sunlight, water and CO<sub>2</sub> as they are not organisms.*

2. (a) *catch:  $2.0 \times 10^3$  tonnes; (accept  $1.7$  to  $2.3 \times 10^3$  tonnes)*  
*year: 1959; (accept 1959-63)*  
*Both needed for [1].* **[1]**

*Allow some flexibility in the exact dates and values quoted in answers to (b) and (d).  
 Also allow use of relative terms such as high, low to describe trends.*

- (b) *description: [3 max]*  
*graph starts at close to zero in 1866;*  
*large increase in catch/yield until 1879;*  
*long-term decline after 1879;*  
*substantial fluctuations from year to year;*  
*e.g. approximately  $8 \times 10^3$  to  $16 \times 10^3$  tonnes between 1885 and 1920s;*  
*yet range remained approximately constant for 35-40 years;*  
*Any other reasonable point.*  
*No marks should be awarded for simply repeating minimum value already given credit in (a).*

*explanation:*

*specific and relevant example of pollution affecting salmon e.g. acid rain;*  
*initially high because resources previously not exploited;*  
*fluctuations might be due to weather/climate;*  
*fluctuations might be due to prices/economic factors;*  
*fluctuations might be due to predator-prey relationships;*  
*long-term decline may be due to overexploitation/exploitation above sustainable yield;*  
*linked to improvements in fishing technologies;*  
*a reduction in catch suggests a reduction in population size;*  
*Any other reasonable points.*  
*At least one “explanation” point is needed to achieve full marks.*

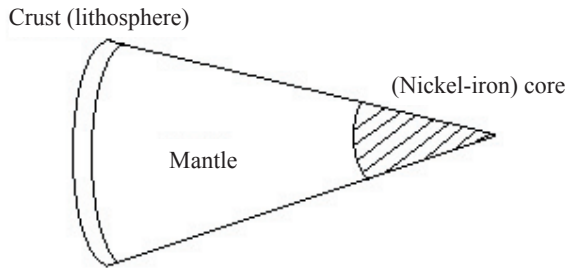
**[4 max]**

- (c) *the rate of increase in natural capital/natural income / the rate at which a resource can be used without the original stock being depleted / the cropping of a resource at such a rate that its long-term productivity is not degraded / OWTTE;* **[1]**

- (d) *sustainable yield may be estimated by long-term monitoring of catch;*  
*catch/yield of  $19 \times 10^3$  tonnes around 1880 may have been above sustainable level;*  
*as this high catch was followed by major fall;*  
*yield of  $8 \times 10^3$  to  $16 \times 10^3$  tonnes between 1885 and 1920s may have been sustainable;*  
*as catch recovered after each fall;*  
*as population declines, so sustainable yield declines;*  
*so long-term decline from 1930s onwards ( $7 \times 10^3$  to  $2 \times 10^3$  tonnes);*  
*may be due to catch being above sustainable yield;*  
*Any other reasonable points.* **[3 max]**

3. (a) open, because the system has inputs and outputs of both matter and energy; [1]
- (b)  $2.0 \text{ (kg ha}^{-1} \text{ yr}^{-1}\text{)}$ ; [1]
- (c) bacterial action within soil / denitrification / nitrification;  
 plant growth;  
 herbivory/consumption of plants by animals;  
 predation;  
 decomposition of organic matter;  
 leaching;  
 excretion/ production of urine/dung;  
 mineral uptake by plants; [1 max]  
*Any other reasonable point.*  
*Do not accept processes that only involve transfer **across** the ecosystem boundary (e.g. migration, burning, lightning).*
- (d) export of organic matter is likely to represent output of nitrogen from system;  
 however, if leaves / bark / twigs are removed before logs are taken loss may be reduced;  
 less vegetation means that fewer organisms immigrate / more emigrate;  
 because of lack of food / shelter;  
 downward loss into roots and subsoil increases;  
 because of lack of interception/absorption by vegetation;  
 burning of timber increases loss of nitrogen to atmosphere;  
 because burning organic matter releases nitrogen oxides;  
 disturbance of topsoil / felling leguminous trees reduces nitrogen input to soil;  
 because microbial communities are disturbed/destroyed; [2 max]  
*Any other reasonable points.*

4. (a) *Diagram may appear as below – a “slice” or a “whole Earth” section may be given. A more complex diagram giving convectional cells/plumes, asthenosphere, etc. is acceptable.*



*Credit any three of the following.*

inner core/core possibly composed of nickel-iron;

mantle between core and crust;

outer relatively thin crust/lithosphere (*thickness may be inferred from diagram*);

division of crust into sial and sima;

convectional plumes/cells;

in asthenosphere;

crust/lithosphere thinner beneath oceans;

**[3 max]**

*Any other reasonable points.*

*Award [2 max] if no diagram is provided.*

- (b) the movement of the (rigid) plates of the lithosphere/crust in relation to each other / OWTTE;

**[1]**

*Syllabus glossary gives “the movement of the eight major and several minor internally rigid plates of the lithosphere in relation to each other and to the partially mobile asthenosphere below”. Allow if a significant portion of this is stated.*

- (c) plate activity:  
divergence of plates leading to isolation of populations (separation of gene pools / resulting in divergent evolution / new species);  
example illustrating this;

formation of barriers and / or land bridges;

example illustrating this;

movement of plates to new climate regions (leading to evolutionary change to adapt to new conditions);

example illustrating this;

volcanic activity / plate collisions producing islands/mountains (leading to diversity of habitats / evolution of new species);

example illustrating this;

convergence of plates (leading to mixing of gene pools causing new adaptations);

example illustrating this;

**[2 max]**

*Any other reasonable points.*

*Examples must give specific geographical location but names of species are not required.  
E.g*

distinctive biota/organisms of Australia (eucalypts/marsupials/monotremes) due to long-term isolation;

similarity of organisms in New Zealand, southern Chile, Tasmania as fragments of Gondwana;

distribution of flightless birds/ratites (emu, ostrich, kiwi, rhea) in Southern land masses as evidence for former continuity of Gondwana;

5. (a) weathering/breakdown of parent rock to produce soil particles (inorganic/mineral component);  
introduction of organisms (the biotic component);  
formation of dead organic matter / humus (organic component); [3]  
*Any other reasonable points.*
- (b) sandy soils contain larger air spaces / loam soils contain smaller air spaces;  
sandy soils are better drained / loam soils have higher water holding capacity;  
loam soils contain more organic matter / sandy soils contain little organic matter;  
loam soils often more productive/fertile / sandy soils relatively infertile/low in nutrients;  
sandy soils are easier to cultivate / loam soils are heavier to cultivate;  
sandy soils have larger average particle size / loam soils have smaller average particle size;  
sandy soils contain fewer living organisms / loam soils contain a wider diversity of living organisms; [2 max]  
*Any other reasonable points.*



## SECTION B

### General Essay Markscheme

Each essay is marked out of **[20]** of which **[3]** are for expression and development of ideas (EDI).

- [0]** No expression of relevant ideas.
- [1]** Expression and development of relevant ideas is limited.
- [2]** Ideas are relevant, satisfactorily expressed and reasonably well developed.
- [3]** Ideas are relevant, very well expressed and well developed.

*Reward detail, sound environmental/ecological concepts, and good examples even if not stated exactly in the form given in the markscheme.*

**6. (a) acid rain [2 max]**

effect tends to be regional;  
acidification of lakes/soils;  
poisoning of fish through aluminium ions;  
accelerated leaching of calcium from soils;  
loss of needles from coniferous forests;  
damage to limestone buildings;  
*Any other reasonable points.*

**global warming [2 max]**

effects are global;  
thermal expansion of oceans / rise in sea levels / flooding of low-lying areas;  
melting of polar ice caps;  
retreat of valley glaciers (Alps/New Zealand);  
changes in climatic patterns;  
increased evaporation;  
*Any other reasonable points.*

**[4 max]**

*Do not credit vague responses e.g. damages plants / kills fish etc.*

**(b) acid rain [3 max]**

SO<sub>x</sub> / NO<sub>x</sub> produced by combustion of fossil fuels (oil/coal/gas) / generating power / use of transport;  
S / N oxides dissolve in water in atmosphere;  
producing acid which falls to ground;  
and may be distributed by winds;  
e.g. Northern England, Scotland, Germany to Scandinavia;

**global warming [3 max]**

CO<sub>2</sub> produced from burning of fossil fuels;  
methane produced by farm animals / rice paddies / landfill;  
CFCs produced from refrigeration, etc.;  
deforestation increases CO<sub>2</sub> levels through burning/decreased photosynthesis;  
increases in levels of greenhouse gases which trap more heat;  
temperature rises as more energy enters than leaves;

**[6 max]**

*Any other reasonable points.*

*Do not reward a point already credited in (a).*

(c) *means of reduction*

reduce use of fossil fuels through energy efficient technology;  
 switch to alternative energy sources *e.g.* solar / wind / tidal / hydro / nuclear;  
 encourage energy conservation measures (heat exchangers, insulation, use of public transport);  
 use low sulfur oils / low sulfur coal;  
 remove pollutants from waste gases from power stations by use of scrubbers;  
 remove pollutants from vehicle exhausts with catalytic converters;  
 use of liming to neutralise lakes/soils;  
 use acid resistant building materials instead of limestone;  
 international/regional agreements/treaties;  
 taxation of emissions;

*evaluate*

many governments dependent on tax revenue from extraction/use of fuels;  
 especially in LDCs with rapidly rising populations/aspirations;  
 many alternative sources have disadvantages *e.g.* aesthetic aspects of solar/wind generation;  
 problems of disposal of nuclear waste;  
 many alternatives are costly / require advanced technology;  
 desulfurisation of coal is costly;  
 scrubbers / CATS expensive to install/maintain;  
 liming is short term solution / can cause further environmental damage due to quarrying;  
 alternative building materials may have other environmental costs / costly to replace old buildings;  
 difficult to implement international/regional agreements;  
*Any other reasonable points.*  
*Award [4 max] if no evaluation is included.*

**[7 max]**

*Expression of ideas [3]*

*Total: [20 max]*

7. (a) *ecological succession* [2 max]

the (orderly) process of change over time in a community/ecosystem / *OWTTE*;  
changes in organisms may be associated with changes in abiotic environment (e.g. soil, microclimate);

successive communities displace each other through competition;  
e.g. volcanic island developing into tropical rainforest;

*pioneer community* [2 max]

the first organisms to colonize a new environment;

usually dominated by producers/plants;

usually dominated by *r*-strategists;

pioneer communities often very simple in structure / low diversity;

tolerate harsh conditions e.g. strong light/low nutrient levels;

e.g. community of lichens covering bare rock (lithosere);

*climax community* [2 max]

the end-point of ecological succession;

in equilibrium / relatively stable;

may have a high level of complexity;

usually dominated by *K*-strategists;

characteristics of climax community determined by climate and soil;

e.g. mature woodland / rainforest ecosystem;

*Any other reasonable points.*

[6 max]

(b) name of ecosystem;

e.g. *sand dune succession on coast of Western Australia*

*Name must be reasonably detailed, e.g. "freshwater" is not insufficient.*

pioneer species very low in number initially;

but numbers increase rapidly with lack of competition;

then decrease later as other species displace them;

rarely reaching their full carrying capacity;

changing abundance follows a J-curve;

eventually climax species become established;

their numbers increase slowly to maximum/carrying capacity;

changing abundance follows an S-curve;

examples of named species showing these changes;

[5 max]

*Award [1] for each of the above [4 max].*

*Any other reasonable points, but they must refer to relative abundance of species, not to diversity for award of credit.*

- (c) gross primary productivity (GPP) – the total amount of organic matter produced/solar energy fixed by photosynthesizing plants per unit area per unit time / *OWTTE*;  
gross productivity initially absent/very low;  
due to initial absence of photosynthesizing organisms;  
increases through pioneer stage as colonization by photosynthesizing plants increases;  
and structural complexity / number of layers increases;  
as green plant biomass increases, gross primary productivity increases;  
GPP usually at its maximum at climax;  
GPP is limited at climax by abiotic factors *e.g.* nutrients / sunlight / temperature / water;  
in some cases GPP declines slightly as older/more woody plants dominate;  
productivity varies seasonally;  
productivity may be affected by human interference; **[6 max]**

*Any other reasonable points.*

*Some of the points above may be scored by means of suitably labelled graphs/diagrams.*

*Do not accept references to secondary productivity or net primary productivity.*

*Expression of ideas* **[3]**

**Total: [20 max]**

8. (a) the maximum number of a species/“load” that can be sustainably supported by a given environment / *OWTTE* (*definition must imply the concept of sustainability*);

*evaluation*

sometimes difficult to measure;

may vary over time *e.g.* due to changes in climate;

may be useful in estimations of sustainable yield of a resource / resource management;

very difficult to measure for humans due to variations in technology / possibility of imports, *etc.*; [3 max]

enables estimation of potential population growth within sustainable limits;

- (b) *The following points may be credited from written description or from clear evidence in graphs, but should not be credited twice.*

fish population might increase rapidly;

“J” curve of population growth;

decline in plants as they are eaten by expanding fish population;

fish population may “crash” as plant food supply exhausted;

possibility of extinction of fish;

this is an example of positive feedback;

but populations may eventually recover;

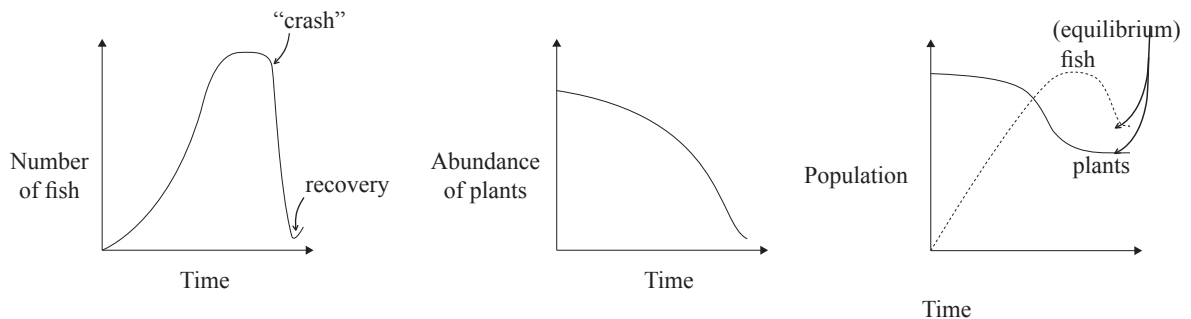
and cycle restarts;

alternatively equilibrium between two populations may be established;

as a result of negative feedback;

reflecting carrying capacity of pool;

*Any other reasonable points.*



[7 max]

*Allow [2 max] for quality of graphs – clarity, relevance, labelling. Graphs must show changes in both plants and fish numbers for full credit, but not necessarily on same graph.*

*Award [5 max] if no graphs provided.*

- (c) carnivorous fish population might increase rapidly with abundant initial food supply;  
decline in herbivorous fish;  
recovery in plants;  
herbivorous fish might be eliminated;  
especially likely in small pool;  
if this occurs, extinction of carnivorous fish will follow;  
unless alternative food sources exist;  
dead organisms will decompose;  
this may contaminate water;  
dead organisms provide basis for decomposer food-chains;  
increases in number of trophic levels/diversity could increase stability of ecosystem;  
correct references to positive or negative feedback mechanisms / density dependence; **[7 max]**  
*Any other reasonable points.*

*Expression of ideas* **[3]**

*Total:* **[20 max]**

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